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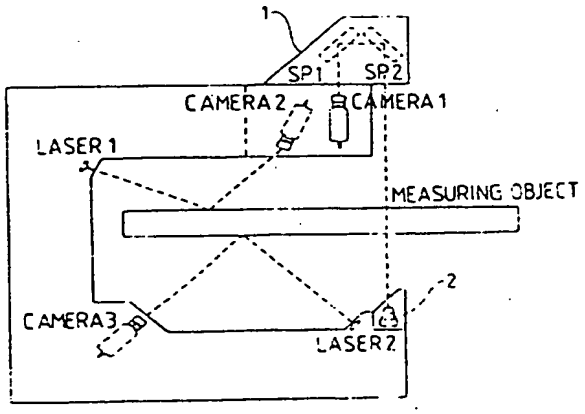

(57) Abstract

A method for touchless measuring of thickness and width of an object travelling along a straight path, based on the use of CCD video camera and laser. The invention is a unit in accordance with the Figure which, by means of installed cameras, laser(s) and two parabola-shaped mirrors, measures both thickness and width of an object as the centre line thereof passes directly below the width measuring camera, camera 1 in the Figure. The device is intended to be coupled to a computer or PC or PLS. Communicating equipment does not become "stuck", occupied with reading measuring values even if the object to be measured becomes laying at rest within the measuring area. Parabola-shaped mirrors are mounted such that they are parallel in the longitudinal direction, and with the concave and mirror-coated sides angled 90° to each other in the plane of the short sides (short dimensions); further, these are positioned with the longitudinal direction parallel with the transport direction of the object to be measured and above the same, such that light and contrast transitions are mirrored in these and recorded by camera 1. The device may be used for e.g. measuring thickness and width of laterally conveyed timber in adjusting works.

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AN ARRANGEMENT FOR OPTIC MEASURING OF BOTH WIDTH AND THICKNESS OF AN OBJECT MOVING ALONG A STRAIGHT PATH

The present invention relates to a device for contactless measuring of both width and thickness of an object moving along a straight path.

The invention could be used for measuring thickness and width of e.g. laterally conveyed wood and timber at an adjustment works.

For a long time, it has been desirable to have a compact solution for contactless measuring of both thickness and width simultaneously, and such that the measuring results could be passed further on to a PLS, a computer or a PC. Rotating objects or sensors touching the object to be measured have, in the long term, been found to cause larger or smaller inconveniences. Some pulse generators used for width measurements have been inclined to transmit pulses due to even small vibrations in the equipment to which the pulse generator is mounted, the measurements being activated by e.g. photoelectric cells. This problem is largest in those cases wherein a plank during measuring has been at rest in the area of measuring for some longer time. Another problem has been that the dull-edge on the wood/timber could contribute to erroneous measurements of both width and thickness. In an attempt to avoid erroneous measuring of the thickness, several values have been received by a computer. Subsequently, one uses the largest value.

This invention solves these problems by means of a single unit measuring both width and thickness touchlessly, and without any movable or rotating parts being included. Measuring both width and thickness takes place only at that moment the central line of the plank or object to be measured passes the centre of the measuring area of the camera. When the camera sees the front edge of the object to be measured, an internal search for the central line of the object to be measured starts. At that moment this is detected, the measuring is carried out. The measuring values are laid out in the order width, thickness 1 and thickness 2. The system initializes itself as soon as the object to be measured is out of the visual field of the camera.

The dull-edge problems illustrated in figure 4 are eliminated in that the CCD camera 11 in figure 5 used for the width measurement sees "around the corner" of the wood/timber piece 12 by means of a parabola-shaped mirror 13.

In order that the device is to function according to its intention, the width measurement, as shown in figure 1, requires camera 1, two parabola-shaped mirrors sp1 and sp2 as well as an elongated light source 2. For the thickness measurement, at least camera 2 and laser 1 are required. In those cases wherein one can not use a safe and sufficiently accurate lower edge reference, one has to use camera 3 and laser 2. For both thickness and width measurement, some electronics for converting the analog video signals to TTL levels is required, and further to digitize the values measured and lay these out to a communication gate, such that they can be fetched by a computer, PLS or PC.

From patent NO 152,987 a system for measuring the diameter of logs is known, by means of light from a light source illuminating a parabolic mirror. From the mirror, the light is reflected toward the object to be measured. On the basis of the shadow portion of the object formed on a detector,

the diameter is found. Use of parabolic mirrors and lights must be considered known on the basis av said patent. However, it is important to note that, in accordance with figure 3 of said patent specification, a power driven rotating plane mirror is used, and that one parabolic mirror only is used in order to carry out the measurement. When figure 4 of the patent specification shows two such mirrors, forming 90° with each other in the longitudinal direction, this is because the measurement in the figure shown is carried out in two directions, and that these two measuring directions are turned 90° in relation to each other.

The purpose using parabola-shaped mirrors is, in addition to what has been mentioned in the preceding section that objects having a given dimension, here width, shall not give differing measuring result when the distance to the object to be measured, or such as in this case, the thickness, varies.

Patent No B 168,271 shows a device for optical measurement of elongated objects, such as sawn pieces of timber. The device comprises a camera, image processing devices and a mirror for reflecting the image of the object. According to the laying-out publication, the mirror may have different forms. However, it is not mentioned that the mirror necessarily has to be parabola-shaped and concave. It is obvious that the intention with the invention is to contract the image of an elongated object more in the longitudinal direction than in the lateral direction of the object, such that either the length only or both width and length of the object simultaneously are measurable by means of one and the same camera which scans the surface of the mirror.

The novel and peculiar of this invention as shown in figure 1 is, in addition to measuring both width and thickness and carrying out the measurement at a defined moment when the central line of the object to be measured passes the centre of the measuring area, also that it - in order to measure

the width - uses two parabola-shaped mirrors together with one CCD camera, in such a combination that one simultaneously avoids deviation of measuring values in that the object to be measured comes closer to the camera as well as avoids the use of motor having plane mirrors or prisms which rotate. The camera which, in order to come away from the measuring zone of its own, looks obliquely into one of the mirrors, searches along a straight line in the longitudinal direction of the mirror. However, the camera will, based on the positioning thereof, in the mirror see a curved picture of an otherwise straight line. The consequence would be that the camera searching in a straight line, would sense only a small part of the image of the straight line. I.a., this is in order to counteract this unfortunate consequence that a mirror No. 2, which otherwise is quite equal to the first mirror, is mounted such that the concave sides of the two mirrors become turned 90° relative to each other in the plane of the short sides (short dimensions). The fact that the angled positioning is in the plane of the short sides, is of substantial importance for this invention. A further and important feature is that the individual components may be mounted so close to each other that they may be assembled in a closed dust-tight cabinet having a narrow, elongated, transparent aperture only, thereby facilitating the cleaning.

Detailed description:

The technical mode of operation is based on the use of cameras, laser, light source as well as parabola-shaped mirrors as shown in figure 1.

Camera 2 and camera 3 as well as laser 1 and laser 2 measure the thickness, camera 1 measuring the width through the two parabola-shaped mirrors sp1 and sp2 mounted in the top portion of the thickness and width measuring device.

Installed electronics digitizes the video information from

the cameras. Each time an object to be measured passes the thickness and width measuring device, the binary number representation for thickness and width laid out to a communication gate.

The thickness measurement:

Figure 2 shows how the thickness is measured. The dotted line 3 frames the area seen by the camera 2. In the course of the camera's horizontal line search No. 150, the camera will see the reflected beams 4 from laser 1. The pulse (7) thus originating on the video signal becomes TTL converted. A counter indicates the length between the line drop and this signal pulse caused by the laser light.

As the laser light in figure 1 has an acute incident angle toward the object to be measured and from the direction shown,

the counting length will become larger the thicker the object to be measured passing the measuring device is. The thickness is measured at the moment the object to be measured passes the centre of the vertical searching field of camera 2. The passage of the central line is detected by the width measuring device. The thickness measured by camera 2 is, in relation to the base upon which the object to be measured rests, in propulsion.

It is necessary to install camera 3 and laser 2 only in those cases where the height level of the lower edge of the object to be measured can be expected to vary.

The width measuring:

Figure 3 shows how the width of the object 5 to be measured is measured by means of camera No. 1. The dotted line 10 shows the visual field of this camera. Lowermost in the figure, video information (9) on search line No. 150 is shown as the object 5 to be measured passes. Contrary to the

thickness measurement, the line search in this case does not take place 90° relative to the direction of motion of the object to be measured, but rather in the same direction.

Without the camera seeing an object to be measured, the light from the elongated light source 8 will enter camera 1 through the two parabola-shaped mirrors sp1 and sp2 in figure 1 and, thus, cause the video information to become saturized (receive maximum amplitude) across the entire area of searching of line No. 150. When, on the other hand, an object to be measured enters the visual field of camera 1 such as shown in figure 3, the voltage level of the video signal (9) will drop as shown in this figure, and be low across the portion of the line laid in the dark by the object to be measured. A counter is activated such that it runs in the time during which the video signal is low. The counted value existing at the output of line No. 154 will, for each new sub image, be overwritten unless the central line (the centre of the width of the object) of the object to be measured has passed in the centre of the horizontal visual field of the camera. This being the case, the last counted value will not be overwritten. Camera 2 and camera 3 measuring the thickness, will ble processed subsequently. The values for these cameras will then, in succession after the width value from camera 1, be laid out to the communication gate together with a "data valid" value, which is the value 1, 2 or 3, dependent on whether the value to be transferred is the value of width, thickness 1 or thickness 2.

Resetting of the values on the communication gate takes place at the moment a new object to be measured enters into the visual field of the camera on one of the lines from 148 to 154. Also, the resetting signal removes the "data valid" signal.

The parabola-shaped mirror contributes to the ability of the camera to "see past the corner" of the object to be measured.

In this way, one avoids the misleading measuring results otherwise originating because of dull-edge when measuring wood and timber. See figures 4 and 5.

C l a i m s

1. A device as in figure 1, installed in a dust-tight cabinet, intended to be coupled to a computer, PC, PLS or other microprocess card for, by means of CCD cameras, mirrors and laser, touchless to measure width and thickness of an object to be measured which moves along a straight path relative to this measuring device, the measurement being carried out when the centre line of the object to be measured passes the centre of the device, c h a r a c t e r i z e d i n that two parabola-shaped mirrors (sp1 and sp2) are mounted, the longitudinal direction thereof parallel with the transport direction of the object to be measured, in mutual positions such that both mirrors, besides being placed parallel with each other, are turned with the concave and mirror-coated sides angled 90° to each other in the plane of the short sides (short dimensions), and further such that light-contrast variations along a straight line parallel with the measured object's direction of travel are mirrored in the mirror (sp2) and reflected from there to mirror (sp1) and from here further inwardly towards a CCD video camera which, in the figure, is denoted camera 1, and which is turned such that line search will take place in the longitudinal direction of the mirror (sp1) and, thus, parallel and coinciding with this line which contains the reflected light-contrast variations.

2. A device as set forth ion claim 1, c h a r a c t e r i z e d i n that one elongated light source (2) is placed parallel with and opposite to the mirror (sp2), in order to emphasize the contrast to an object to be measured and which is to pass between the light source (2) and the mirror (sp2).

3. A device as set forth in claims 1-2, c h a r a c t e r i z e d i n that one CCD camera, in figure denoted as camera 2, is mounted such that it forms an acute angle relative to the horizontal plane of the object to

be measured, and such that the camera's horizontal direction of search is perpendicular to the measured object's direction of travel.

4. A device as set forth in claims 1-3, c h a r a c t e r i z e d i n that one laser, i figure 1 denoted as laser 1, transmitting a light beam in a direction such that it, when it reaches the object to be measured, on the top thereof will stand out as a narrow strip parallel with the object's direction of travel, is placed such that the transmitted light beam thereof additionally falls inwardly towards the object to be measured at an acute angle in relation to the horizontal plane of the object to be measured.

5. A device as set forth in claims 1-4, c h a r a c t e r i z e d i n that the thickness of the object, in accordance with figure 1, is measured in that camera (2) and laser (1), in addition to the arrangement as mentioned in claim 4, are mutually positioned such that the laser light (4) reflected from the measured object as illustrated in figure 2, will be within the visual field (3) of the camera (2), and modulated into the video information (6) and, further, that one let a counter run in the time between the video signal's (6) line drop and the pulse (7), and that the counter value is evaluated in relation to either a previously known reference, which may be the base on which the measured object rests, or that it is evaluated in relation to the result of measurement carried out of the location of the lower edge of the object and, based on the same measuring principle, by further using a camera as shown in figure 1 as camera (3), and one laser shown as laser (2) in the figure.

6. A device as set forth in claims 1-5, c h a r a c t e r i z e d i n that the width is measured, as shown in figure 3, in that the object (5) to be measured which is conveyed past the visual field (10) of the camera

(1) and in the same direction as the line searching direction of this camera, causes the video information (9), over those lines which are searched parallel and coinciding with the underlying elongated light source (8), receives a lower voltage level over a length corresponding to the width of the object to be measured, and that one let a counter run in this time, such that the counter's value at the output of the line, thus, becomes a measure for the width.

7. A device as set forth in claims 1-6, c h a r a c t e r i z e d i n that the time when the measured object's centre line passes centrally below camera (1) is detected.

8. A device as set forth in claims 1-7, c h a r a c t e r i z e d i n that the width value measured last prior to centre line detection, is accepted as valid.

9. A device as set forth in claims 1-8, c h a r a c t e r i z e d i n that camera (2) and camera (3) in figure 1 become processed in succession immediately subsequent to the passage of the centre line, and the values for thickness are laid out to a communication gate together with a "data valid" value each, after the width value with its associated "data valid" value has been laid out.

10. A device as set forth in claims 1-9, c h a r a c t e r i z e d i n that all units necessary for the device shall function according to its purpose are mounted in at least one dust-tight cabinet.

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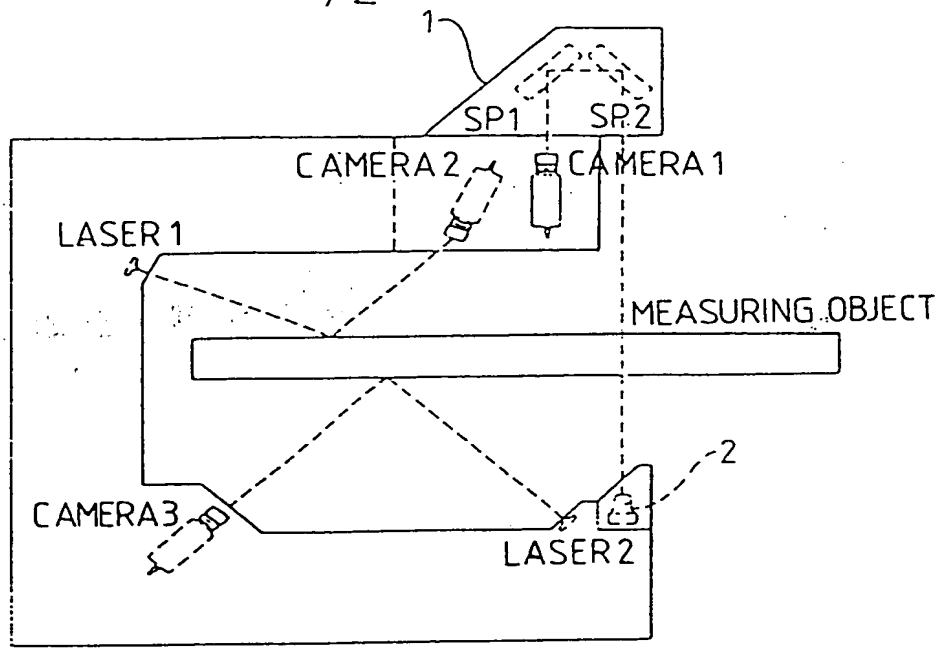

Fig. 1

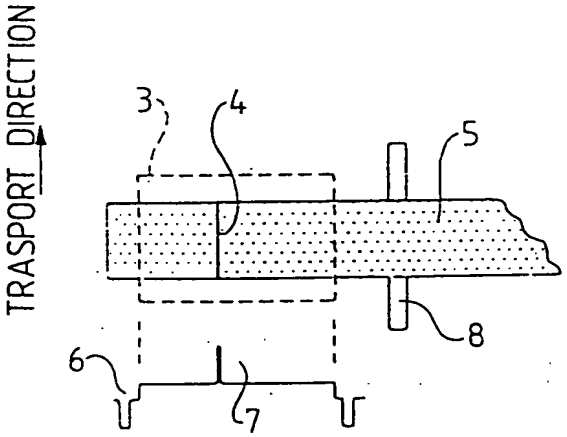

Fig. 2

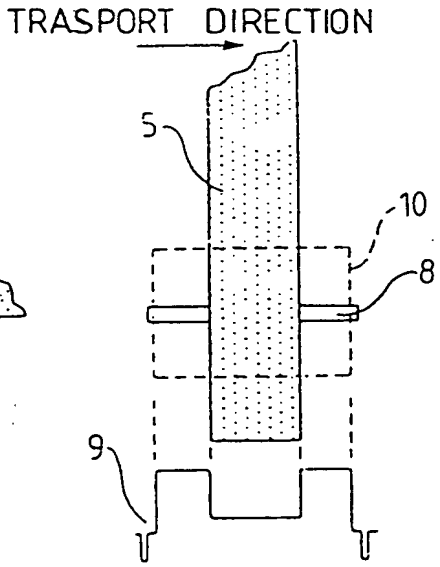

Fig. 3

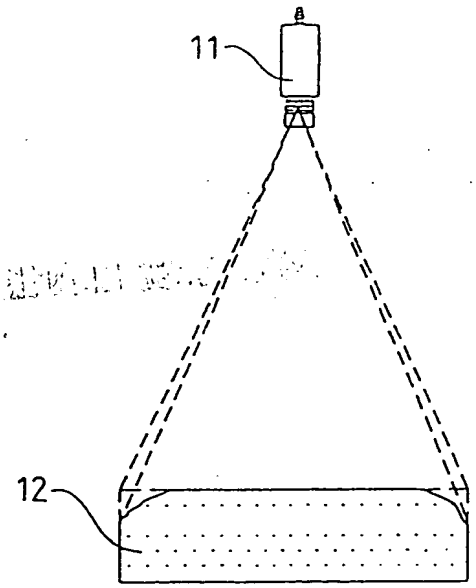

Fig. 4

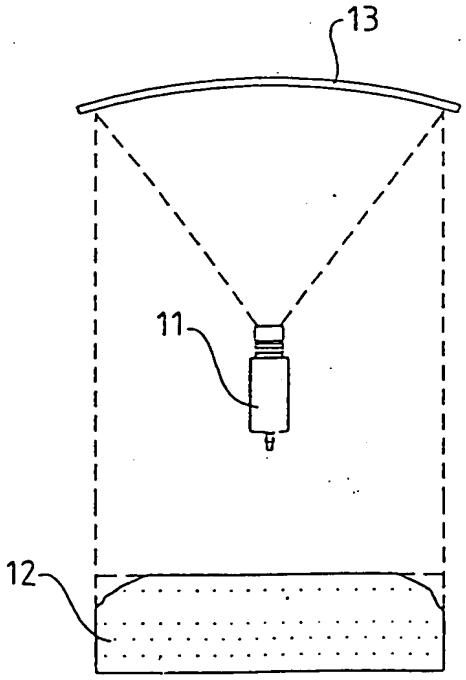

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 94/00076

A. CLASSIFICATION OF SUBJECT MATTER

IPC : G01B 11/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE, C, 2945456 (SATT CONTROL AB), 22 May 1980 (22.05.80) --	1
A	DE, C, 3500815 (KOSKENOHI KIMMO), 18 July 1985 (18.07.85) --	1
A	EP, A, 0250089 (TOLE, WALTER ROLAND), 23 December 1987 (23.12.87) --	1
A	GB, A, 1223400 (CENTRE NATIONAL DE RECHERCHES METALLURGIQUES), 24 February 1971 (24.02.71) -- --------	1

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Information on patent family members

28/05/94

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-C- 2945456	22/05/80	AT-B- 385847	25/05/88
		FR-A,B- 2441148	06/06/80
		SE-B,C- 414543	04/08/80
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		SE-A- 8500204	18/07/85
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		BE-A- 708100	17/06/68
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		FR-A- 1222233	00/00/00
		FR-A- 1562548	04/04/69
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